

**THE NITROGEN CHALLENGE:
BUILDING A BLUEPRINT FOR NITROGEN
USE EFFICIENCY AND FOOD SECURITY**

Proceedings of the 18th Nitrogen Workshop

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INITIALIZING THE DSSAT-CENTURY MODEL: INVERSE CALIBRATION OF CARBON POOLS FROM APPARENT SOIL N MINERALIZATION

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The CENTURY soil organic matter model was adapted for the DSSAT (Decision Support System for Agrotechnology Transfer), modular format in order to better simulate the dynamics of soil organic nutrient processes (Gijsman et al., 2002). The CENTURY model divides the soil organic carbon (SOC) into three hypothetical pools: microbial or active material (SOC1), intermediate (SOC2) and the largely inert and stable material (SOC3) (Jones et al., 2003). At the beginning of the simulation, CENTURY model needs a value of SOC3 per soil layer which can be estimated by the model (based on soil texture and management history) or given as an input. Then, the model assigns about 5% and 95% of the remaining SOC to SOC1 and SOC2, respectively. The model performance when simulating SOC and nitrogen (N) dynamics strongly depends on the initialization process. The common methods (e.g. Basso et al., 2011) to initialize SOC pools deal mostly with carbon (C) mineralization processes and less with N. Dynamics of SOM, SOC, and soil organic N are linked in the CENTURY-DSSAT model through the C/N ratio of decomposing material that determines either mineralization or immobilization of N (Gijsman et al., 2002). The aim of this study was to evaluate an alternative method to initialize the SOC pools in the DSSAT-CENTURY model from apparent soil N mineralization (Napmin) field measurements by using automatic inverse calibration (simulated annealing). The results were compared with the ones obtained by the iterative initialization procedure developed by Basso et al., 2011.

Material and Methods

The initialization method developed in this work (Met.2), was compared with the Basso et al. (2011) procedure (Met.1), by applying both methods to initialize the SOC pools of a 4-year field experiment in a semiarid irrigated area of Madrid (40°03'N, 03°31'W, 550 m.a.s.l.). The main crop of the experiment was maize alternating with three cover crop (CC) treatments: barley, vetch and fallow. An additional control treatment was also included without fertilization to determine Napmin during the 2008 and 2009 maize period. The CENTURY model was initialized for the control treatment through the two methods, obtaining two different sets of SOC3 pools. Crop coefficients and soil parameters were also calibrated. For the model validation in the fallow, barley and vetch treatments, the obtained values of SOC3 from the two initialization methods were used separately.

Results and Discussion

The resulted SOC3 fractions were lower for Met.1 than for Met.2 in the top three layers. Since the total SOC was the same for both methods, a smaller SOC3 fraction would mean higher fractions of the active and slow pools (SOC1 and SOC2) in Met.1 than in Met.2. Method 2 improved the simulation of Nmin in the control plots as the Napmin was calibrated with actual conditions (78 kg N ha⁻¹ in 2008 and 79 kg N ha⁻¹ in 2009). Method 1 resulted in overestimation of the observed Napmin and Nmin in

the control plots (180 kg N ha⁻¹ in 2008 and 155 kg N ha⁻¹ in 2009). The simulated N dynamics in the fallow, barley and vetch treatments presented higher Nmin in Met.1 than in Met.2 due to the higher proportion of the SOC1 and SOC2. Simulation of N leaching in the soil was similar for both methods showing a decrease in the nitrate leaching when replacing bare fallow with cover crops during the intercropping period. The Met.1 provided higher SOC1 and SOC2 fractions resulting in a higher Napmin and smaller cumulative SOC than Met.2. In both methods, Napmin was slightly higher in the CC treatments than in the bare fallow while SOC was smaller in the fallow than in the CC treatments.

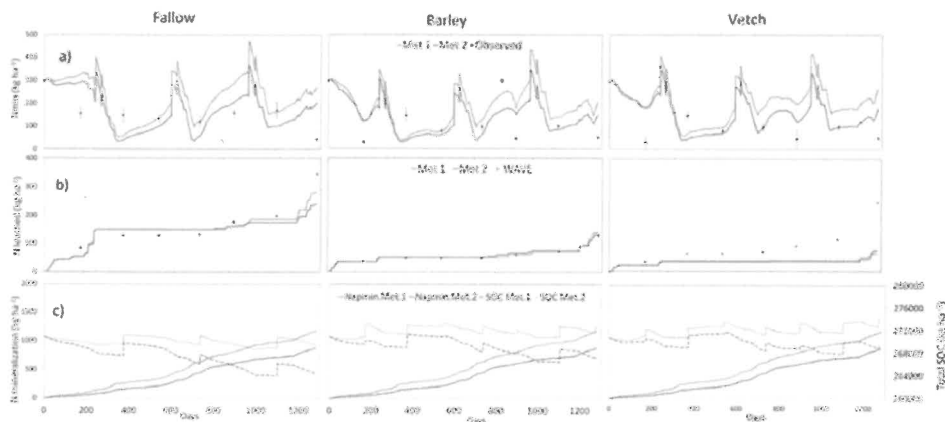


Fig.1. (a) Nmin, (b) N leached (kg ha⁻¹) leaching and (c) Napmin and soil organic carbon (SOC) evolution for the fallow, barley and vetch treatments comparing the two methods of CENTURY initialization: Met 1: Century initialization following the iterative procedure; Met 2: Century initialization based on field Napmin measurements.

Conclusions

The automatic inverse calibration of the initial carbon pools from Napmin measurements demonstrates to be an effective initialization method for several reasons: it is based on field observations that can be easily measured; it ensures a good simulation of the Napmin; it makes a close estimation of the N leaching and the Nmin. Therefore, it leads to reliable simulations of all the components of the soil N balance keeping a proper simulation of crop growth. Thus, when Napmin measurements are available, we recommend to use Met.2 to initialize the CENTURY model. This work highlighted the importance of the initialization procedure on the CENTURY model performance when simulating SOM dynamics, as the results can vary significantly with one initial SOC fractions or another.

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